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RESEARCH ARTICLE

The integrated Ethics and Society Program of the Human Brain Project: Reflecting on an ongoing experience

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The integrated Ethics and Society Program of the Human Brain Project: Reflecting on an ongoing experience

The EU-funded Human Brain Project (HBP) aimed to deliver advances in brain science, cognitive neuroscience and brain-inspired computing which would have broad-ranging implications and benefit European citizens. Achieving such outcomes is dependent, in part, upon the ability of large scale research projects to anticipate potential needs and concerns of user communities as well as other stakeholders and society in general and integrate these into their research program. While the responsibility to anticipate such needs and to address them belongs to all those directing the research programme, the HBP has a specific Subproject dedicated to researching society and ethics issues. This seeks to enable research across the HBP to better incorporate societal concerns and ethical awareness into their research design and trajectory. This article describes the structure of the Ethics & Society Subproject, reflects on our experience three years in, and considers some of the challenges in formulating and implementing such a program for Responsible Research and Innovation (RRI).

Keywords: neuroscience; neurotechnology; Human Brain Project; responsible research and innovation; foresight

1. Introduction

On 15-16 September 2016, the OECD, in collaboration with the School for the Future of innovation in Society at Arizona State University and the National Science Foundation, organised a workshop on "Neurotechnology and Society: Strengthening Responsible Innovation in Brain Science." hosted by the National Academies of Sciences, Engineering and Medicine in Washington, DC. As a social scientist participating in the Ethics and Society programme of the Human Brain Project (HBP), the European 'big brain' research initiative, one of us was invited to participate in the panel dedicated to "Programmes in Brain Research and Neurotechnology: Mechanisms Connecting Scientific and Social Outcomes." The objectives of the session, which also involved representatives from the American, Cuban, Indian, Israeli and Korean brain research initiatives, was to canvass major projects in brain research and neurotechnology to identify what they see as the key social issues raised; to

learn how they are attempting to include ethical and social issues in their work; and discuss more reflexive mechanisms to connect scientific and social outcomes.

In the present paper, building from the original contribution to these objectives, we – collaborators in the HBP Foresight Laboratory at King's College London – analyse and reflect on our experience of an integrated Ethics and Society programme in a large brain research project, three years into the project. The paper is not a normative conceptualisation of methods, nor is it a particular set of recommendations towards the governance of neurotechnology. Instead, it is a 'view from the trenches,' a located, experiential and partial (in the sense of both incomplete and biased) perspective on the practice of being social scientists embedded into a large multidisciplinary brain research consortium. We do not claim that our views and opinions reflect those of other members of the HBP, and not even of others in the HBPs Ethics and Society programme. We first give a broad picture of the Human Brain Project and of the mechanisms, part of a Responsible Research and Innovation (RRI) approach, by which ethical, legal and social dimensions are integrated into the project. We then reflect on our practice and experience over the first 30 months of the project, to March 2016 – the so-called Ramp-Up Phase. We conclude by drawing a few experiential lessons.

2. The Human Brain Project

The HBP is a ten year Future and Emerging Technologies Flagship initiative of the European Commission,[2] involving around a hundred research institutions. Its overall aim is to create an ICT-based scientific research infrastructure for brain research, cognitive neuroscience, and brain-inspired computing (including the development of neurotechnology such as neuromorphic computing, neural networks algorithms, or neurorobotics, and also high-performance computing and data analytics tools optimized for neuroscience).

Computer science was to be involved in HBP neuroscience in two ways. It was argued that to successfully analyse and derive new insights from the amount and complexity of neuroscientific data, new computational infrastructure and techniques are required (The HBP-PS Consortium 2012, 8-9; The HBP Consortium 2015, 7-8). Reciprocally, the insights of neuroscientific discoveries were expected to contribute to more efficient and effective computing, generating capabilities that can be deployed in novel ways within the economy

[2] http://cordis.europa.eu/fp7/ict/programme/fet/flagship/home_en.html, accessed 21 Nov 2016.

(The HBP-PS Consortium 2012, 8-9; The HBP Consortium 2015, 7-8). The HBP's proposal emphasized that multilevel integration of neurological knowledge was key to reaching its strategic objective for future neuroscience, which was to 'achieve a unified, multi-level understanding of the human brain that integrates data and knowledge about the healthy and diseased brain across all levels of biological organization, from genes to behaviour; establish *in silico* experimentation as a foundational methodology for understanding the brain,' (European Commission 2014, 44) through interconnected information technology (IT) platforms. The HBP would be 'putting in place a cutting-edge research infrastructure that will allow scientific and industrial researchers to advance our knowledge in the fields of neuroscience, computing, and brain-related medicine' (Viola 2016). The project is divided into Subprojects about half of which are focused on research and the generation of strategic data resources (Mouse Brain, Human Brain, Cognitive and Systems Neuroscience, Theoretical Neuroscience) and the other half are building the IT platforms composing the infrastructure (Neuroinformatics, Brain Simulation, High Performance Analytics and Computing, Medical Informatics, Neuromorphic Computing, and Neurorobotics). Our Foresight Lab is a part of the Ethics and Society Subproject (SP12) (The HBP Consortium 2015, 48-72).

The HBP was launched in October 2013, and soon generated significant criticism. In July 2014, an open letter to the European Commission signed by several hundred scientists asked for changes to the management structure and the scientific focus of the project.[3] Criticisms targeted a number of interrelated issues. Some doubted the promises made by leaders of the HBP that they would be able to simulate the human brain within ten years (regarding the promises themselves, see for instance, Markram 2009; European Commission Staff Working Document SWD(2014)283 2014, 30-31). Some were concerned that funding of this project would drain national and European resources away from other neuroscience research. Some criticisms were linked to a perception that computational neuroscience was being favoured over other approaches in neurobiology – even though the funding for the HBP came explicitly from a scheme designed to support emerging technologies rather than neuroscience itself. Some were based in disputes within the neuroscience modelling community between those who favoured so-called 'top down' or 'model driven' approaches over the 'bottom up' or 'data driven' approach preferred by the initiator of the HBP, Henry

[3] "Open message to the European Commission concerning the Human Brain Project," http://www.neurofuture.eu/, accessed 27 Apr 2017.

Markram (on 'data driven' vs 'model driven' approaches, see for instance Dudai and Evers 2014, Eliasmith and Trujillo 2014). Some thought that it was inappropriate for both the scientific direction and the management of such a large project to lie in the same hands, and that this structure was inimical to an open and participatory relationship with the broader neuroscience community (for different perspectives on the issues at stake, see "Brain fog" 2014, Abbott 2014, Enserink and Kupferschmidt 2014, Frégnac and Laurent 2014, Neuroskeptic 2014, Seth 2014).

A subsequent mediation process and the first annual EC review process led to the scientific re-focusing of the HBP and a new governance structure. They required a closer integration of the data and theory Subprojects with the development of the IT platforms, and re-integration of a systems and cognitive neuroscience Subproject; translating the six projected platforms into a solid integrated ICT infrastructure, and drafting an accompanying roadmap for user recruitment; and revision of the governance structure to distinguish scientific direction from management and to increase the involvement of the Commission and the supporting national research councils in the governance of the HBP. The aim was for the HBP to overcome the fragmentation of its multiple parts, at the same time as it opened itself up to a pluralism of views and approaches. In the Operational Phase that follows the Ramp-Up period, the HBP should become a very different project, with an independent legal entity managing a commonly shared European research infrastructure (The HBP Consortium 2015, 75-77) which aims to join the European Strategy Forum on Research Infrastructure (ESFRI)[4] and so to continue to exist after the Flagship funding scheme expires. However in this paper, we focus on the 30 month Ramp-Up Phase only.

3. Responsible Research and Innovation (RRI)

There are many different definitions of, and approaches to, RRI, and there are significant differences between approaches in the UK, in the EU and in the USA, as well as in other regions. René von Schomberg probably articulates best the most general aspirations of the European approach, arguing that RRI is an 'interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process' (von Schomberg 2012). Such an emphasis on dialogue between 'societal actors' and researchers

[4] http://www.esfri.eu/, accessed 01 Dec 2016.

and innovators arises out of dissatisfaction with earlier approaches, such as those framed in terms of 'Ethical, Legal and Social Implications' – the ELSI research most associated with the Human Genome Project (HGP) which was widely believed to have generated neither high quality research, nor, most importantly, to have had any discernible impact on the development of the HGP itself (Fisher 2005, Greenbaum 2013, Seltzer et al. 2011). As research funding, such as that from the European Commission, increasingly came to frame itself in terms of the need to meet society's 'Grand Challenges',[5] it appeared more urgent to ensure that societal actors were effectively engaged in defining those challenges and that the research and development was on course to address them (EUC 2008, Kuhlman and Rip 2014; Kallerud et al. 2013, Kearns and Wienroth 2011, ERAB 2012, GCC 2011, Greenbaum 2013). However it was also widely recognised that engendering such a relationship between scientific research, stakeholders and citizens was exceptionally difficult. Most of those involved were painfully aware of the so-called Collingridge dilemma: early in the innovation process there are ample opportunities to direct or regulate the path of development but there is usually insufficient evidence to justify choices; however, when sufficient evidence is gained from observing impacts of the new technology over time, it is difficult and costly to change the path of development, because the technology has become integrated into existing infrastructure (Collingridge 1984).[6]

While many different methods have been developed to overcome these difficulties,[7] RRI has emerged in Europe as the leading framework within which these approaches should be developed. Particularly influential has been the so-called AREA approach developed in a number of policy reports for the UK Economic and Physical Sciences Research Council, consisting of four dimensions, Anticipate, Reflect, Engage, Act.[8] These are usefully elaborated by Stilgoe, Owen and Macnaghten (2013) in slightly different terms as follows: *Anticipation* is an attempt to describe and analyse the potential impacts, intended or otherwise, (e.g., economic, social, environmental) that might arise from the outcomes of the research, not to predict a single most probable outcome but to explore both anticipated and, to the extent possible, unanticipated impacts and implications. Consideration of alternative scenarios may

[5] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges, accessed 08 May 2017.
[6] See also Rosenberg (1994); Arthur (1994); David (1997).
[7] For examples see Bimber (2000); Schot & Rip (1997); Guston & Sarewitz (2002); Fisher et al. (2006); Barben et al (2008); Guston (2011, 2014); von Schomberg (2012); Wynne (2011); Owen et al. (2012); Stilgoe et al. (2013).
[8] https://www.epsrc.ac.uk/research/framework/area/, accessed 21 Nov 2016.

improve the capacity of various actors to deal with both expected and unexpected possible futures. *Reflexivity* entails working with the researchers themselves to develop a situated awareness of their location and impact within a research and innovation system. Thus, reflexivity might include reflecting on purposes, motivations and potential implications of the research, particularly in relation to others elsewhere in the research system or outside of it, i.e. stakeholders, users of neurotechnologies, members of the public. This entails some awareness of associated uncertainties, areas of ignorance, assumptions, framings, questions, potential dilemmas, and social transformations these may bring.[9] *Inclusion* is the opening up of such visions, impacts and questioning to broader deliberation, dialogue, engagement, and debate in an inclusive way. *Responsiveness* is the ability of these different actors within the innovation system, including consumers of innovation, members of the public, or other stakeholders who may be formally outside of the research community, to learn from one another and act in such a way as to adjust the outcomes of a research process.

The HBP Ethics and Society Subproject has built on the AREA approach, rather than that suggested by the EU itself.[10] We have also stressed the need for RRI in practice to be *integrated* across the whole pathway of research. *Anticipation* occurs by *inclusively* engaging researchers with stakeholders and experts to think *reflexively* about the research system and their position within it. Possible outcomes become apparent when people from different parts of the research programme interact – not just among themselves but also with others outside the programme. Taking action (being mutually *responsive* to different actors concerns, i.e. social learning) happens when research strategies and intended outcomes are adjusted based on these dialogues.[11] As we discuss below, this is how our HBP Foresight Lab work was conducted.

[9] Within our society and ethics component of the HBP program *reflexivity* was re-labelled 'researcher awareness' for greater clarity of meaning to researchers, however our RRI process also aimed to encourage reflexivity in policy, public, stakeholders or other actors.

[10] In Horizon 2020, RRI is defined as 'an approach that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation.' It includes public engagement, but also open access, gender balance, science education (https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation, accessed 27 Apr 2017) and 'ethics' which is taken to mean research integrity, guidelines on the involvement of children, patients, vulnerable populations, following laws and regulations on the use of human embryonic stem cells; minimising research on animals and non-human primates, and a focus on privacy and data protection (https://ec.europa.eu/programmes/horizon2020/node/767, accessed 27 Apr 2017).

[11] Stilgoe et al. [2013, 1573-74] argue for the need to integrate the four dimensions of the AREA approach. Socio-technical integration research (STIR) focuses on the process of bringing social issues into the innovation process to reconsider potential social impacts of what would otherwise have been

Establishing an RRI process that successfully embodies these principles, particularly in a complex, large scale project like the HBP, is a challenge. Such efforts rely on the good faith of participants, require adequate resources, and must be carefully adapted to the particular circumstances of the research situation and relevant stakeholders. There is no guarantee that all parties will agree or that consensus will be the outcome of such a process. However, in principle, innovation choices, including the choice *not* to go forward with a proposed innovation, can be better informed by an RRI process. Developing and testing RRI practices that might be adapted for use in other research situations is part of the wider research agenda of the Ethics and Society Subproject of the HBP.

4. Integrating ethical, legal and social dimensions into the HBP

From the earliest meetings of the group that eventually led to the proposal for the Human Brain Simulation Project, which later became the HBP, it was agreed that there must be a specific dimension or 'pillar' of this project that focussed on social and ethical issues (see Section 4.4). In the proposal that was adopted, this work was gathered into one Subproject, the Ethics and Society Subproject (SP12), and over the course of the Ramp-Up Phase, SP12 also put in place two other mechanisms – an external and independent Ethics Advisory Board[12] (EAB); and an Ethics Rapporteurs programme to ensure that concerns raised in all the various Subprojects were brought to the attention of SP12 and the EAB. We will now detail these various components and their relationships.

4.1 The Ethics and Society Subproject

The Ethics and Society Subproject (SP12) explores the social, ethical and philosophical implications of the Human Brain Project. It is fully integrated into the core research of the HBP, and receives between 4 and 4.5% of the total budget of the HBP. Regarding the actual figures, the European Commission's announcement of one billion euros award[13] for the ten year long Human Brain Project has been widely publicised but this figure needs to be

considered merely technical matters: see Fisher et al. (2008), https://cns.asu.edu/research/stir, accessed 21 Nov 2016.

[12] The EAB started out in the Ramp-Up Phase as two separate advisory bodies, the Research Ethics Committee (REC) and the Ethics, Legal and Social Aspects Committee (ELSA). These two bodies were merged following the re-organisation of the HBP governance in 2015.

[13] https://ec.europa.eu/eip/ageing/news/human-brain-project-receive-one-billion-euro_en, accessed 28 Apr 2017.

relativized. For the 30 months of the Ramp-up Phase, the HBP core project was granted 54 million euros by the European Commission out of an overall cost of 72.5 million euros, and the budget of SP12 amounted to 3 million euros overall. For the 24 months of SGA1, the overall budget envelope of the core project is 89 million euros, with 4 million for SP12.

Through research and practice, SP12's role is to foster RRI within the HBP, by promoting engagement with decision-makers and the general public, and by raising social, conceptual and ethical awareness among project participants. This involves identifying potential ethical, social and conceptual concerns at an early stage, addressing them in an open and transparent manner, and providing the scientists and infrastructure builders in the HBP with opportunities to evaluate the reaction of diverse audiences to their work, so that they can adapt their objectives and processes accordingly. While initially SP12 focussed on these RRI aspects of its work, as the HBP developed, and in particular in the aftermath of the mediation process and review mentioned earlier, it has become clearer that, from the point of the Commission, a key role of SP12 was to provide 'ethics management', that is to say to ensure that all the research conducted by the HBP complies with relevant legal and ethical norms. In a large and heterogeneous consortium of dozens of research laboratories undertaking a whole range of research, this is no easy matter. It is important to stress that all the work conducted in SP12 is undertaken in close collaboration with researchers in the various HBP Subprojects most directly involved, and that seeking, gaining and maintaining this collaboration is a vital part of RRI as we conceive it. We will now outline the various dimensions of our approach, including the ethics management part that was added midway through the Ramp-Up Phase.

Work Package WP 12.1, Foresight Analyses and Researcher Awareness, is where the Foresight Laboratory, which the present authors represent, is located. It undertakes foresight studies on key aspects of the HBP, linked to the AREA dimension of 'anticipation', and in the Ramp-Up Phase it focussed on data protection and privacy, the search for 'neural signatures' of brain and mental disorders, problems of community building, and the challenges posed by developments in artificial intelligence and robotics. In the Operational Phase of the HBP, it includes a second area of work, 'Researcher Awareness' (a separate work package during the Ramp-Up Phase), linked to the 'reflect' dimension of the AREA approach. Researcher Awareness aims to take the issues initially raised in foresight work to the researchers and other members of the HBP in order to increase their capacity to reflect on ethical, social and regulatory issues, and to bring the results of those reflections back into the continuing work of the Foresight Lab, thus contributing to the closure of the AREA loop.

Work Package WP 12.2, Neuroethics and Philosophical Analyses, focuses on conceptual clarification. In the Ramp-Up Phase it explored the meanings of the term 'simulation' and also examined questions of consciousness, particularly in the context of disorders of consciousness such as persistent vegetative states, and the emergence of neurotechnologies that aim to identify residual consciousness in such patients. During the next phase covered by the Specific Grant Agreement 1 (SGA1), it will continue the exploration of consciousness disorders, and also focus on the role of cultural imprinting in understanding the brain's functional architectures, and on the philosophical and ethical challenges of modelling cognitive processes in silico.

Work Package WP 12.3, Public Engagement and Communication, is in charge of citizen dialogue and consultation and of facilitating the engagement between HBP scientists and external stakeholders in 'Stakeholder Forums' and other practices of citizen engagement, conducted in many European countries, on issues of possible controversy.

Work Package WP12.4, Ethics Management, develops principles and implementation of Ethics Management in the HBP (such as Standard Operating Procedures and the mapping of ethical issues), manages ethical compliance, and supports the other components involved in integrating ethical, legal and social dimensions into the HBP: the external Ethics Advisory Board, and the Ethics Rapporteurs programme. Ethics Management is a much expanded version of what used to be Work Package 12.5, Governance and Regulation, in the Ramp-Up Phase.[14]

Finally, a fifth Work Package, WP 12.5, Scientific Coordination, is responsible for the management of the Subproject, and for ensuring a strong cooperation not only within SP12 itself but also between SP12 and the rest of the HBP, by participating in different cross-project instances coordinating communication, management, science and technology.

4.2 The independent Ethics Advisory Board (EAB)

The EAB is an independent body that advises the HBP Board of Directors on specific ethical, regulatory, social and philosophical issues raised by research that is being undertaken and planned by, or in association with, the Human Brain Project. While they were established by the Steering Committee of SP12, they are operationally independent, although their

[14] Compliance management in the HBP is detailed in a Standard Operating Procedure: https://docs.google.com/document/d/14HngjWhbRqjLBjTDeP8S3nICSyqL_VJO7ZQm5yn5t0I/edit#heading=h.u8zn54w6ojai, accessed 28 Apr 2017.

administration is managed within the Ethics Management Work Package.[15] The EAB and SP12 typically have a joint meeting once a year, in which we discuss issues of common interest and, where appropriate, identify shared areas of concern upon which we intend to work.

4.3 An example of collaboration between SP12 and the EAB: Data protection and privacy in the HBP

Exchanges between the EAB and SP12 have resulted so far in collective work on data protection and privacy, on which an Ethics and Society Opinion has been jointly written by members of the different Work Packages in SP12 and of the EAB, and has been presented to the Directorate of the HBP.[16]

Following the recommendations of the EAB-SP12 Data Protection and Privacy Opinion, SP12 is undertaking various targeted actions. A cross-project Data Governance Working Group, coordinated by the Ethics Management, has been approved by the HBP Scientific and Infrastructure Board, and it has developed a number of concrete propositions, now approved by the HBP management: a Data Policy Manual for use as reference across the HBP, as well as the creation of a HBP Data Protection Officer (DPO) position. The position has been advertised internally within the HBP Consortium in April 2017, to be active until the end SGA1 (March 2018). It is intended that the DPO role will be continued in the SGA2 phase (April 2018-March 2020) via an open call. Other actions involve a number of webinars run by WP12.3, Public Engagement and Communication. Two have already taken place as of April 2017, one on informed consent in the HBP,[17] and one on self-tracking devices in the HBP.[18]

Another area of joint interest for the EAB and SP12, on which both groups have been working, is that of dual-use, that is to say, the potential for civilian research ostensibly directed towards clinical or other peaceful uses to be utilised for military, security, intelligence or political purposes. This is an issue where there are widely divergent opinions

[15] For more information, see the EAB Standard Operating Procedure: https://docs.google.com/document/d/1RHuOuHiV2f90yaUdsCTVMjjnF2piIIioXNpcXxqTWdM/edit, accessed 28 Apr 2017.
[16] https://sos.exo.io/public-website-production/filer_public/55/6b/556ba8a4-9b93-4454-9278-09f7105625a6/ethicsandsocietyopiniondataprotectionandprivacy.pdf, accessed 28 Apr 2017.
[17] http://www.tekno.dk/article/stakeholder-forums-in-the-human-brain-project/?lang=en, accessed 28 Apr 2017.
[18] http://www.tekno.dk/article/webinar-on-self-tracking-in-the-human-brain-project/?lang=en, accessed 28 Apr 2017.

between countries, often embodied in different funding regimes and organizational forms – for example the US BRAIN initiative is funded to a significant extent by the Defence Advanced Research Projects Agency (DARPA) which is an agency of the US Department of Defence.

4.4 The Ethics Rapporteurs Programme

The Ethics Rapporteurs Programme realises cross-SP ethics coordination and liaison with the EAB as well as with SP12. It is managed and supported by SP12 Ethics Management Work Package. Helping the other Subprojects to enhance their capacities to anticipate ethical issues that will arise during the course of the project is one important task of SP12. Related to this is to support them in establishing early warning signals processes to identify ethical concerns, thereby making those visible and manageable. The so-called Ethics Rapporteurs appointed in each Subproject are there to ensure that ethics issues in their respective Subprojects are brought in good time to the attention of the EAB. They are tasked with describing and explaining the infrastructure building and research activities ongoing in their respective Subprojects, identifying potential ethical, legal or social issues, keeping colleagues in their Subprojects informed on matters of Ethics Management, participating when required in creating and disseminating relevant Standards Operating Procedures (SOPs) in their respective Subprojects, supporting each other in their rapporteur role, and reporting on the implementation and impact of SOPs.

4.5 The Originality of the Management of Social and Ethical Issues in the HBP

No other brain project, indeed no other big science project that we know of, has such an integrated set of mechanisms for exploring social and ethical issues under the framework of RRI. We can illustrate this through a comparison with the Graphene Flagship, which was chosen and launched alongside the HBP as Future and Emerging Technology (FET) Flagship Initiative of the European Commission in October 2013.[19]

As early as 28 July 2010, during the first meeting in preparation for the FET Flagship Program held in Lausanne, Jean-Pierre Changeux (Institut Pasteur, Paris) and Yadin Dudai (Weizmann Institute of Science, Rehovot) presented the original mission of what was then the 'Society and Ethics Pillar' of the 'Human Brain Simulation Project' as 'to ensure

[19] http://cordis.europa.eu/fp7/ict/programme/fet/flagship/6pilots_en.html, accessed 07 Nov. 2016.

upstream engagement of the project with its ethical and social aspects,' and listed a number of very concrete challenges that the future FET Flagship would have to address in this respect, such as 'potential public anxiety concerning intrusiveness and perceived violation of individuality, privacy and human uniqueness' and 'fear of misuse of specific project outcomes by government, including military & police, commercial interests, crime.' In November 2011, following a number of discussions among a small group of experts convened by Changeux and Dudai,[20] the shape of what was then termed the 'Society and Ethics Pillar' had already coalesced into a set of 'goals' that matches closely the present tasks of the actual SP12 – foresight: industrial, economic and social consequences of HBP; conceptual and philosophical issues; public dialogue and stakeholders engagement; researchers awareness; governance and regulation; and the scientific coordination of the Ethics and Society group.[21] As a consequence, in the April 2012 report for the Human Brain Project Pilot, it was deemed essential given the large potential impact of the HBP research and technology,

> … that the project follow a policy of Responsible Innovation. The HBP should thus include a far-reaching Society and Ethics Programme, funding academic research into the potential social and economic impact of HBP research, and its ethical and conceptual implications, managing programmes to raise ethical and social awareness among HBP researchers, and, above all, encouraging an intense dialogue with stakeholders and with civil society that gives full expression to inevitable differences in approaches and values. (The HBP-PS Consortium 2012, 12)

By contrast, in the April 2012 report for the Graphene Flagship Pilot, there was no overall responsible innovation strategy, and social concerns focused exclusively on enabling industrial applications and unlocking socio-economic impact, through the challenges of technology transfer and Intellectual Property Rights (IPR) management. They did not extend to the funding of academic research into the potential social and economic impact of Graphene research, and its ethical and conceptual implications (Kiranet et al. 2012, 29-32).

[20] One of the present authors, who had previous experience in integrating RRI in another emerging biotechnology, synthetic biology, participated in this group.
[21] Jean-Pierre Changeux, personal communication.

Four years later, the HBP and the Graphene Flagship have both completed their Ramp-Up Phase, and have started on the 1st tranche of their Operational Phase funded under the Horizon 2020 Framework Programme for research and innovation (H2020) of the European Commission (EC). Over this period of time, the European Union has worked towards institutionalising its approach to responsible innovation in science and technology, RRI becoming an integral part of H2020. Yet the difference between the two FET Flagships remains striking. As we have seen, the HBP has developed its dual objective of research and practice for implementing RRI, already outlined in the Flagship Pilot report, into a fully-fledged strategy and a distributed yet coordinated organisation for supporting it. Meanwhile, no comparable organisation and strategy has been implemented in the Graphene Flagship. There is no integrated 'research and practice' Division (the rough equivalent of the HBP Subprojects), or Work Package, dedicated to Ethics and Society. Ethics is managed, in regulatory compliance tradition, alongside legal, finance and administration in Work Package 18, Management.[22] The governance of Graphene includes a Strategic Advisory Council predominantly geared towards the management of intellectual property and the development of partnerships, but no equivalent to the Ethics Advisory Board of the HBP.[23] The implementation of the RRI agenda, a key feature of the Flagship Action Plan, has translated into the creation of Work Package 4, Health and Environment, which aims to address the potential risks of graphene to the health of animals, humans and the environment, by identifying and solving any possible safety and toxicity issues of graphene-based materials (European Commission Staff Working Document SWD(2014)283 2014, 15-20).[24] Led by a team of nanoscientists, its risk-management strategy consists in devising ad hoc technological fixes to graphene-specific issues arising in areas already delimited in the general context of nanotechnology.

Having identified the originality of the approach to RRI adopted in the HBP, and given a broad picture of the organisation that has been set up to implement this strategy and its diverse components, we now turn to the part of the HBP Foresight Lab in this ensemble.

[22] http://graphene-flagship.eu/project/divisions/Pages/divisions.aspx and http://graphene-flagship.eu/project/divisions/Pages/Work-Package-14--Management.aspx, accessed 08 Nov. 2016.
[23] http://Graphene-flagship.eu/project/management/Pages/Strategic-Advisory-Board.aspx, accessed 08 Nov. 2016.
[24] For details of Work Package 4, see http://graphene-flagship.eu/project/divisions/Pages/healthandenvironment.aspx, accessed 08 Nov. 2016.

5. The HBP Foresight Lab: reflecting on our practice and experience

5.1 The work of the HBP Foresight Lab

In the HBP Subproject 12, Ethics and Society, the role of the HBP Foresight Lab is to undertake foresight studies on key aspects of the Project. Very early on, a decision was taken that, at least in the Ramp-Up Phase, we would engage with short to medium term (i.e. 3 to 10 years) issues of specific relevance to the work of the HBP, rather than speculative projections about the longer term implications of this kind of computationally based neuroscience research and development.

Foresight, when applied to technology development is a process that involves anticipating changes and identifying a range of plausible future possibilities linked to technological innovations.[25] Our approach, based loosely on the *scenario principle* (described below), differs significantly from forecasting, which is perhaps the most common engineering method for considering technical futures. While forecasting is the attempt to predict the single most probable future, foresight, however, considers multiple possible and plausible futures, especially in contexts of ineradicable uncertainty. As Angela Wilkinson has put it:

> In forecasting, the emphasis is on what is knowable in advance from evidence of the past. Uncertainty is treated as a 'lack of knowledge'. In periods characterised by rapid and stable growth, forecasting has proved to be a reliable approach to predicting the future. In situations characterised by complexity, turbulence and ambiguity, over-reliance on forecasting can be a fatal error. (Wilkinson 2009)[26]

It is also worth noting that our *scenario principle* work was methodologically attentive to historical knowledge. Recently published work on the disciplinary origin of neuroscience (Rose and Abi-Rached 2013) as well as a grounding in oral history methodologies informed our data collection. The role (or lack thereof) of historical research

[25] For details of various methods that have been used in Foresight endeavours, see http://forlearn.jrc.ec.europa.eu/guide/4_methodology/methods.htm, accessed 27 Apr 2017. Many EU nations have foresight projects. For the UK, see https://www.gov.uk/government/collections/foresight-projects, accessed 27 Apr 2017.

[26] In our approach, we did not use a fully-fledged scenario process as discussed by Wilkinson; (see also Ramirez and Wilkinson 2016; van der Heijden 2005).

in developing successful strategies for responsible innovation has been noted before, sometimes controversially (Nordman 2014, Wilsdon, 2014, Guston and Sarewitz 2002, 101).

In the Ramp-Up Phase of the HBP, we wrote three foresight reports based on extensive research and consultation with HBP researchers, discussions at the workshops where we presented our scenarios, and interviews with external 'stakeholders' drawn from the relevant scientific, industrial and civil society communities. These reports, which we discuss in more detail below, sought to identify and outline key issues that might arise in conjunction with the work plans of the HBP. In addition to helping the researchers themselves focus on and articulate key future issues, the reports were intended to provide feedback to HBP directors, researchers, and other concerned actors in the form of background information on relevant socio-political issues, reviews of related research and recommendations. They were also directed to other important audience such as the scientific community outside the HBP and civil society organisations representing public interest.[27]

The topics of the three foresight reports were chosen to match the initial tripartite division of the HBP research strategy: 'future medicine', 'future neuroscience', and 'future computing and robotics.' For each report we first carried out an extensive period of 'horizon scanning', examining the literature, both academic and popular, interviewing key scientists, and identifying key themes and questions. We also had access to interviews with senior HBP researchers on ethical concerns collected as part of initiating SP12 Researcher Awareness work package. For each report we then held two or more webinars (on-line seminars accessible to participants over the internet) co-organised with the Danish Board of Technology Foundation which focussed on key themes and were open to an invited audience of 25-35 persons. In these webinars, we posed key questions about future directions, potential alternative pathways, risks and benefits, and we recorded and analysed the debate.[28] We used systematic foresight techniques, including in some cases scenario construction based on narrative and fictional short scenarios (vignettes). We then held workshops with HBP researchers and other stakeholders, at which we used the vignettes and other material as prompts to explore the plausibility of alternatives and the role of different research design decisions in the production of outcomes both positive and negative. This collaborative

[27] This wider work with the European public is also taken forward through our links with colleagues in the HBP Ethics and Society Subproject, who are undertaking widespread citizen consultations, using a variety of methods described elsewhere.

[28] Recordings can be found on the YouTube channel of the Danish Board of Technology Foundation: https://www.youtube.com/user/teknologiraad/videos.

process was designed not only to collect data for the report, but also to facilitate interaction and reflexive debate in the research community, and to identify key issues for further discussion between researcher and stakeholder communities.

Future Medicine

For this first report, we worked with Subproject 8, the Medical Informatics Platform (MIP). The MIP is an ambitious attempt to federate hospital-based patient data which would then be mined in an attempt to identify 'brain signatures' - distinctive patterns that could both individuate and diagnose disease. It was hoped that these brain signatures could help distinguish individual disorders more accurately than current techniques, which are largely based on classification by observable symptoms rather than underlying pathology.[29] The report focused on issues of data protection and privacy raised by accessing and analysing patient records, as well as the nature and consequences of the search for brain-based 'signatures' of psychiatric and neurodegenerative diseases, and their potential use in personalised medicine. In relation to data protection and privacy, we identified that legality and trustworthiness were key challenges for the future development of the MIP, and that addressing these challenges would require not only measures for technology management, but also community-building activities around the MIP that would involve diverse categories of stakeholders, in particular clinicians and patient groups (Rose, Aicardi and Reinsborough 2015a). Some of our recommendations have since been incorporated into the joint EAB-SP12 Data Protection and Privacy Opinion and are now part of its subsequent action plan (including recommendations to conduct a Privacy Impact Assessment, and to reach out towards patient groups like Alzheimer Europe).

Future Neuroscience

For our second report, focused on future neuroscience, we directly engaged with brain modelling communities within and outside the HBP to explore the challenges of bringing together diverse approaches to modelling and simulation, especially given the perceived hostility of many in that community to the approach taken within the HBP. The process itself was an exercise in community building: we began by inviting key figures from key brain

[29] For example, from a genetic point of view, Single Nucleotide Polymorphisms (SNPs) are associated with mental disorder but are often pleiotropic (having more than one effect). (Cross-Disorder Group of the Psychiatric Genomics 2013).

modelling communities outside the HBP ('key' as identified by the HBP researchers themselves, who were keen to reach out to try and establish connections with these particular stakeholders), both from Europe and the United States, to the Fondation Brocher in Hermance (Switzerland) to discuss with HBP platform designers and modellers, issues of scaling up data collection, bridging scales of analysis (cellular, circuit level, cognitive intention, etc.), and the social and institutional arrangements of the neuroscience community. At this workshop, we were able to bring together such key figures from each community, working at different scales, with different model organisms, and adopting different methodologies. This face-to-face meeting, with plenty of time for informal discussion, small group work, and informal jousting over beer, was crucial in helping overcome the significant distrust and suspicion of the Human Brain Project, and the perception that it was seeking to impose its particular form of modelling: that the HBP planned to create "one model to rule them all" as it was put by one participant. An atmosphere of open dialogue enabled us to explore the practical, socio-technical and human challenges of building the infrastructure required to enable datasets collected by different laboratories with various social and technical arrangements to be made commensurable, and the incentive structures for sharing data.[30] We also considered ways in which the labour of programmers, crucial for building data analysis infrastructure, might be rewarded in an academic system focused on authorship of scientific papers. Our report proposed strategies to build a neuroscience community, emphasised the importance of open source modelling in order to build trust, cooperation, and to minimise duplication of effort and maximise synergies (Rose, Aicardi and Reinsborough 2015b, 2015c).

Future Computing and Robotics

For our third report on future ICT and robotics, we identified the broad contribution that computational neuroscience might make to intelligent machines research and provided a plausible framework for artificial intelligence in terms of human – machine systems that augment human intelligence (rather than serve as a replacements). We also surveyed affective computing, the impact of robotics/automation on employment within the economy, and potential military applications of computational neuroscience research, particularly those

[30] An earlier US based NSF funded project for computational neuroscience (also called the Human Brain Project) also addressed this difficult issue (Koslow 2000).

which might emerge from non-military applications/ so-called dual- use technologies.[31] The main implications that we have identified for the next 5-10 years are broader issues not coming out specifically of the research conducted in the HBP, but to which several strands of HBP research could potentially contribute. They are the implications that developments in artificial intelligence will have, and have already, in such domains as affective relations between humans and autonomous machines (in particular, care of vulnerable populations and the sex industry); the global labour market (with the replacement of human workforce by robots and computers); all domains relying heavily on data analytics capabilities (e.g. marketing, insurance, credit scoring), with issues of data protection and privacy, data misuse and abuse, algorithmic opacity, etc; defence, security and military applications; energy consumption and electronic waste. Regarding the HBP research concerned, we have found that there were deep potential interconnections between different parts of the project, and through them, close links between the fields of research involved and their applicative domains. A primary recommendation is that a systematic, project-wide reflection should be conducted to take stock of these synergetic potentials as well as the ethical and social issues that they may raise (Rose, Aicardi, and Reinsborough 2016).

Reflexivity and capacity building

Foresight is most closely associated with the '*anticipatory*' dimension of RRI, but this is necessarily integrated with other dimensions. In our work we chose to engage broadly with HBP scientists and other experts to learn from them what issues they felt might be of concern. We asked them to be *reflexive* about plausible outcomes of their research. To the extent that this process brought multiple actors into dialogue, we were opening up the possibility of *responsiveness*. In this sense our foresight research is itself a model of *integrated* RRI work more generally, rather than simply being the 'anticipatory work package' within a larger set of RRI work packages.[32]

[31] The HBP has a clearly articulated policy of not being involved in military research or accepting military research funding.

[32] For a similar description of the process of integrating societal concerns into innovation processes that relies primarily on the anticipatory dimension but integrates all dimensions see Barben et al. (2008) or Guston (2011, 2014).

5.2 Challenges

Over the past four years, we have encountered a number of challenges that have shaped the directions, and possibility, of our foresight work on neurotechnology in the HBP. It is not possible to examine them all in this essay, and we therefore focus on a few key issues.

The Collingridge Dilemma ripple effect

The Collingridge Dilemma is a staple of technology assessment debates. It is named after David Collingridge's insight, in his 1980 book *The Social Control of Technology*, that efforts to influence the development of technology face a double-bind, the 'dilemma of control': "When change is easy, the need for it cannot be foreseen; when the need for change is apparent, change has become expensive, difficult and time consuming." (Collingridge 1981, 11). In our foresight work, we have experienced first-hand the 'ripple effect' of the Collingridge Dilemma: it can become a shield for scientists and engineers against the demand for ethical accountability.

Although an explicit commitment of the HBP is to drive forward European industry, a majority of the scientists and engineers involved consider that it is, fundamentally, a basic research project. Their work is geared towards research rather than commercialisation. While many believe that the research is likely to have social and ethical implication in the medium or long term, most do not think this should have immediate implications for their own research. For example, while much of the project contributes to brain-inspired computing and robotics, presenting much potential for developments in neurotechnology, the prevailing view is that while these technological developments can have huge potential ramifications, they are unpredictable, difficult to envision at the outset, and impossible for the researchers themselves to control. In part, this is because many consider that their work is mostly geared towards basic neuroscientific research, and that while it could potentially play a part in very many different commercial applications, these will have a whole variety of currently unpredictable implications. Researchers tend to hope that their research has potential for beneficial applications that respond to societal needs, and to think that potentially negative ramifications require oversight from other social actors or regulatory bodies, which lies outside their expertise and their potential to control. Even where researchers do have significant concerns about potentially problematic outcomes (such as the misuse of research outputs in the development of unethical autonomous systems and artificial intelligence

applications, in particular for military purposes), they seldom feel that these have an immediate import for the nature or direction of the research they are doing within the HBP.

This widespread feeling of insulation from foreseeable social and ethical impacts, linked in part to a belief in lack of power to influence them, and its accompanying feeling of disconnection from immediate social and ethical responsibility, is an important challenge for many of us in the Ethics and Society Subproject. In the case of the HBP Foresight Lab, given that it is indeed the case that much research in the HBP is focussed on basic science, a consequence is that we have to anticipate a translation from research to commercialized and industrialized application that goes beyond the current work of the researchers who we hope to influence. Nonetheless this projection of HBP research into its wider sociotechnical and economic context, which entails also raising awareness among researchers of lessons from previous scientific and technological developments, is itself a 'capacity building exercise' that aims to encourage reflection beyond a list of detailed and often uninformative technological features and research breakthroughs (Rose, Aicardi, and Reinsborough 2016).

The synchrony mirage

It is sometimes assumed that 'upstream engagement' involves embedding RRI into large multidisciplinary research projects from the outset, and thus will ensure that scientists and engineers will become more reflexive in their work from a very early stage, bringing societal considerations to bear on the development of new scientific and technological research from the start (see for instance, Wilsdon and Wills 2004; see also Fisher et al. 2006). In our experience, the 'from the outset' part of the assumption might be a useful to envision as textbook ideal but is questionable in practice.

In the case of the HBP, it was simply not possible to build RRI into the work of the researchers 'from the outset' in a way that one might imagine an ideal example of anticipatory governance (Guston 2014) or mid-stream modulation (Fisher et al. 2006) would do. In fact, in many labs, much of the scientific research that would come to be within the HBP had already been underway for some time. Thus part of the research conducted under Subproject SP6, Brain Simulation Platform, is provided by the Blue Brain Project at EPFL,[33] started in 2005; research in Subproject SP9, Neuromorphic Computing Platform, comes in part from the SpiNNaker project at the University of Manchester, started in 2005,[34] and in part builds

[33] http://bluebrain.epfl.ch/page-56882-en.html, accessed 28 Apr 2017.
[34] http://apt.cs.manchester.ac.uk/projects/SpiNNaker/project/, accessed 28 Apr 2017.

on the BrainScaleS project at the University of Heidelberg,[35] itself a successor of the FACETS project also started in 2005.[36] This lack of synchrony is not specific to the HBP - most scientific research is well under way before it receives specific funding that contains an RRI obligation. As a result, embedded social scientists and humanities scholars tasked with implementing a RRI strategy into large multidisciplinary projects cannot work as upstream or even midstream as they would wish: research trajectories are already set and they are usually already quite far downstream. This has important implications for the kind of RRI-like approaches it is then possible to use, and for how they can be deployed, not least in foresight activities.

Who is responsible for ethics?

Perhaps the fundamental question that our work highlighted was this simple one: who is responsible for the social and ethical implications of a project such as the HBP? In particular, what is the role and the responsibility of those conducting its RRI dimensions? We were very clear that those in the HBP Ethics and Society Subproject were not an 'ethics police force' nor indeed were we the ethics regulators. We were not a substitute for the normal ethical review procedures that each element of HBP research had to go through in their own institutions according to their own local and national laws and regulations. And although, in the course of the various reviews of the HBP, one Work Package of SP12 took a more active role in 'ethics management' (developing Standard Operating Procedures, and procedures of record keeping and monitoring to ensure that research had obtained appropriate ethical approval and was being conducted according to approved ethical guidelines), in our understanding and enactment of RRI, this was essentially an audit operation; ethics management was by no means at the heart of responsible research and innovation.

What then was our role, and how were we to explain this to HBP scientists, to other stakeholders, to HBP directors and perhaps most challengingly, to HBP ethics reviewers? Were we teaching the researchers, facilitating their learning, or learning from them? What does "mutually responsive" mean? How could one assess 'being reflexive' in such contexts? Who decides how research design should be amended to reflect societal concerns? Who has the 'responsibility' in Responsible Research and Innovation? In short, *who does the ethics work?* It was important to be clear that we were not there to do the ethics for them; that was

[35] https://brainscales.kip.uni-heidelberg.de/, accessed 28 Apr 2017.
[36] http://facets.kip.uni-heidelberg.de/, accessed 28 Apr 2017.

their job.[37] The aim of the HBP Foresight Lab was to facilitate a process, to help HBP researchers identify and adapt to societal concerns; and it was important for us to repeatedly counter the belief by some – both within and outside the project - that 'ethics' was in some way being outsourced to the 'ethics' Subproject.

In our discussions with HBP researchers during our workshops, webinars and on-going participation in the HBP, we frequently encountered an active concern by many of them about ethical and social issues.[38] This active concern runs counter to the belief that most computing and neuroscience researchers do not concern themselves with the societal and ethical issues raised by their research. Indeed the scientist in the lab working with materials, models, and concepts may actually be the first person to consider a future technology or application, and hence often the first person to consider its societal impacts or potential ethical issues. The first source of data for any type of foresight scoping work may well come from the researchers, computer scientists and engineers themselves; further, in many cases, they may also be the best people to propose solutions (Fisher, Majahan, and Mitcham 2006; Wynne 2011). The aim of foresight is to support such reflections, to build capacity, to share experiences, and to provide a legitimacy, a forum and a voice for such social and ethical deliberations (Barben et al. 2008, van der Heijden 2005). This is why there is a close link between the work of the Foresight Lab and that of Researcher Awareness – a link that we are strengthening in our ongoing work.

In this sense, RRI work is interventionary in a way that most social science research is not. When HBP researchers come together with diverse publics, this helps facilitate reflection by bringing people with different types of expertise, interest, and position within the innovation system into conversation with one another. In the long term, this type of

[37] As we have said, individual laboratories are accountable to their local research ethics committee, and HBP Subprojects, including our own, are all accountable to EU ethics reviewers during a periodic review. Even the independent EAB is not responsible for ensuring ethical probity but instead advises HBP scientists and directors on what action they might take with regard to ethical concerns.

[38] Although, as we have noted above, there was also by some a lot of distancing from ethical responsibility, through the claim that uses of basic science research could not be controlled so therefore it was not their responsibility. This highlights that the 'responsibility' notion may be problematic, and we can think of several reasons for that: lack of a clear distinction between responsibility and accountability; lack of a level of organisational responsibility, without which the individual researcher must either assume responsibility personally or claim that there cannot be responsibility for what the individual cannot control; and the pervasive culture of blame, an artefact of the no less pervasive culture of accountability. Identifying structural reasons for individual or organisational failure and at the same time identifying and encouraging institutional support for existing researcher ethics knowledge (even if held by a minority of the research community) is part of the role of the social scientist supporting the development of best practice within the research institution.

integrative work is intended to develop the capacity of researchers to understand their own role in the innovation system. Likewise, it may inform civil society, entrepreneurs, policy professionals, and experts from other fields about future applications and their potential impacts.

5.3 Some lessons from our experience

As we have said, the intention from the very early discussions of the HBP was to include a dimension or 'pillar' responsible for exploring social, conceptual and ethical implications. As these developed, approaching the actual submission of the proposal that was successful, some elements were fleshed out - in particular the importance of foresight, the need for conceptual analysis of the premises and methodologies of the HBP, the importance of public engagement, and the need to enhance researcher awareness. This early configuration of SP12 lent itself especially well, a posteriori, to the broad AREA framework for RRI proposed by the EPSRC in the UK, rather than mirroring the 'six keys' of the EC framework.

We mentioned earlier that the mediation process and various EC reviews of the HBP, in relation to public concerns and scientific controversy, led to an extension and strengthening of the ethics management role of SP12, including the designation of one member of this Subproject as the Ethics Manager for the whole of the HBP. Although it was undoubtedly true that, at some points, ethics management has risked becoming seen as the prime task of SP12, minimising its RRI role, this has been successfully resisted so far, and the enduring value of the work of foresight, of conceptual exploration and of public engagement, has been recognised as integral to the HBP as it enters its Operational Phase. However there is no doubt that the twin roles of our Subproject, for RRI and capacity building on the one hand, and for formal ethics management on the other, often generate uncomfortable tensions. While the research components of SP12 focus on informal engagement opportunities with the rest of the HBP, in which we participate in committees and workshops with the same status as the other researchers, the Ethics Management work package has a formal role of devising, implementing and auditing standard operation procedures, ethical compliance, etc. Our view was that it was necessary to keep these two dimensions distinct, so that interactions through more informal channels with collaborators across the HBP with the aim of trust building and capacity building do not become identified with formal ethical oversight. It is a delicate balancing act to build trust relationships and to

keep informal channels of engagement open and separate from the formal ones through which oversight and audit operate.

We will illustrate the value of opening up, and keeping open, such informal channels of engagement, through the example of the work that the Foresight Lab has done, and continues to do, on community building around the developing HBP research infrastructure. This became the focus of our foresight work on future neuroscience as we adapted in response to the rapid changes of objectives and organisation occurring in the HBP in the aftermath of the mediation process and reviews already mentioned. Understandably in view of the amount of attention and criticisms that they had received, neuroscientists in the project tended to withdraw into themselves and went through a phase of soul searching. Engaging with them required a level of interpersonal trust that could not be achieved through formal channels. Our chance was that such a feeling of trust towards the Foresight Lab had already been progressively established, a key element of which was the presence in one of the core HBP simulation lab of a doctoral student associated to our work, who was conducting there her ethnographic fieldwork. Without the informal channels of engagement that we had so established, one of us would never have been invited along with the doctoral student (on the premise that social scientists like us looked like they had insights that could prove useful), to an invitation-only workshop organised in London by the HBP simulation lab along with another HBP neurobiology lab, bringing together modellers and experimentalists from within and without the HBP all working on a particular area of the brain. Following this workshop, it became clear to us that community building was a major challenge for the HBP, and we offered neuroscientists in the project to use the opportunity of our upcoming workshop at the Fondation Brocher, and co-organise with us a larger-scale exercise in community building (see paragraph on *Future Neuroscience* above in 5.1; for more details, Rose, Aicardi and Reinsborough 2015b). The Brocher workshop provided a sheltered space where issues could be frankly and openly discussed, and it was very well received, by all involved. Evidence of the perceived value of our contribution and trustworthiness, the two researchers who had participated in the first closed workshop in London have been invited to participate in a follow-up workshop[39] aimed at taking stock and consolidating the community building that had started then.

Further, while RRI does provide a broad framework for our research and activities, the Ethics and Society Subproject brings together a rich diversity of research traditions, skills

[39] To be held 23-24 May 2017 at the European Institute for Theoretical Neuroscience in Paris.

and practices. We will never, and neither should we, be a seamlessly integrated interdisciplinary group, although we are a well-coordinated and cooperative multidisciplinary group, and this is because every part of our work is designed, not simply to inform and engage external stakeholders and other interested parties, but also to influence and shape the research and development trajectory of the sprawling variety of research projects that constitute the HPB. Indeed closing the AREA loop is the hardest challenge, and to find the mechanisms whereby the recommendations and opinions of SP12 actually do influence, and in some cases determine, the directions and management of the HBP research.

We are developing a number of mechanisms to address this issue. In the new structure of governance, some of our recommendations will be formally put to the Science and Infrastructure Board of the HBP for adoption and then for monitoring. Another approach is that of 'Opinions' – similar to those produced by some national ethical councils. In the Ramp-Up Phase, SP12, drawing for part on our first Foresight Report, worked with the Ethics Advisory Board to develop the joint Ethics and Society Opinion on Data Protection and Privacy, which was then followed up with a series of concrete propositions to the governing bodies of the HBP (section 4.3 above). We will follow this model in the future, and select broad topics of special importance and relevance to the HBP, which will be the subject of foresight analysis, conceptual exploration, public engagement, citizen dialogue, stakeholder discussion and so forth, and feed into the production of a collective SP12 opinion. This will contain evidence-based recommendations that will be developed into an action plan, which will be presented to the governing boards of the HBP, and, if accepted, will be monitored with the support and intervention of the ethics management team where required. The topic chosen to be the focus of our next opinion, developed in this way, will be 'dual use' – that is to say, the potential military uses of research and development initially designed for non-military purposes.

6. Conclusion

Strengthening responsible innovation in brain science raises many challenges. In this essay, we have explained how, within the remit of the Human Brain Project, some of these challenges were tackled through the development of a RRI strategy. To conclude, we would like to offer some pointers arising from our experience, as to what current RRI frameworks and approaches may be lacking.

6.1 The critical depth of time

The critical lens of history is largely missing from current RRI frameworks and related approaches. While the potential value of history for anticipatory work has from some corners been promoted and occasionally, strongly defended, it has overall failed to receive adequate funders' attention (Kranakis 1988, Guston and Sarewitz 2002, 101; more recently, the role of history became a topic of debate for the inaugural issue of the *Journal of Responsible Innovation*, see Nordman 2014, Wilsdon 2014). This is unsurprising if we consider – historically – where these various frameworks and approaches originate from. They follow from previous technology assessment approaches and Ethical, Legal and Social Aspects / Issues (ELSA/ELSI) frameworks (van Oudheusden 2014, Rip 2014, Zwart, Landeweerd, and van Rooij 2014), which typically brought together ethics, moral philosophy, law, political and social sciences, but historians and archivists have been, and still are, conspicuously absent. Let us illustrate through a couple of practical examples how it could enrich a RRI strategy such as the one deployed by the HBP.

First, in the context of the present Special Issue and of the workshop it builds up from, it is worth asking why neurotechnology and the brain deserve special importance and consideration in relation to society. More precisely, it is worth interrogating the reasons why, at this particular junction in time, we think that it does, as witnessed for instance through the global multiplication of 'big brain science' projects or through the proliferation of neuro-prefixed terms. The special status given to the human brain, its current overriding importance in all things concerned with the mind and mental health, are too often uncritically taken for granted, when they deserve instead to be questioned. While it is possible for researchers to philosophically and reflexively consider this question, it is also important to examine current ideas about the human brain through a historical lens (see for instance, Rose and Abi-Rached 2013). For instance, historical inquiry may reveal intersecting and little explored genealogies that would bring the concurrent rise to prominence of computational neuroscience and machine learning into new perspective. This could, in turn, bring new insight into wider sociotechnical trends: here is a first and most obvious aspect in which history could explicitly enrich the HBP strategy for RRI, and this is indeed how the benefits of historical approaches for technology assessment and responsible innovation has mostly be envisioned (Kranakis 1988, Guston and Sarewitz 2002, 101, Nordman 2014, Wilsdon 2014).

There is another less obvious but no less important potential benefit of historiography (as historical methodology), which is never mentioned in relation to RRI and related

approaches. To be fair, it is seldom embraced by historians themselves, and is more likely to find traction among archivists. It is what we could call 'historical provisions.' Building on García-Sancho's call for 'proactive historians' (García-Sancho 2016), the idea stems from the observation that there will be future need to situate the present moment in the long multifaceted history of our understanding of the brain and mind. This could become a major challenge. We may simply discover too late that there is a scarcity and inadequacy of evidence documenting the current rapid growth of 'big brain' projects worldwide. A key factor is the lack of resources to create archives as the projects unfold, which could be then used for future transnational and comparative historical studies. Even the projects that have integrated ethics and society programmes such as the HBP do not have built-in provisions to create proper archives for future historical studies, to learn from experiences, and to look back and see what worked, how innovation was distributed in society, and if and how opportunities were realised.

6.2 Reflexivity for RRI

It is also important to consider how, if at all, the work of RRI is too be credited, not just in the field of social science, but to the extent that it furthers the aims and objectives of the work of emerging technologies themselves. If it is the case, as we believe, that well-conceived and implemented RRI approaches are essential to the success, or partial success, of large scale research whose ambition is to address compelling social challenges, then RRI cannot be consigned – as perhaps was the case with ELSI or public engagement – to the peripheral task of managing public acceptability. In our own case, the foresight work conducted with those in the neuroscience modelling communities broke down boundaries, smoothed opposition, and proposed new approaches and methods for collaboration, and for the apportioning of credit. If the HBP efforts at building an open research infrastructure for modelling and simulation efforts are eventually successful, it will be in part because of our work. There is much more to RRI than regulation, openness, gender balance and research integrity – well conducted, it is essential to robust science, successful development, and to socially responsible technological change. This is not a narrow question of the apportionment of academic credit to RRI researchers, important as this might be in the real world of academic. More fundamentally, as Rose (2012) has argued, the role of RRI is to make scientific research and development more robust, more viable in the everyday world outside the secluded environment of the laboratory, more democratic and supportable by a scientifically literate

and engaged citizenry, and more likely to successfully address those grand social challenges that inspire it and justify the social investment to support it.

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